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Notes on gasteroid fungi of the Brazilian Amazon rainforest

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Abstract — Studies of gasteroid fungi have been limited in Brazil, where the group is poorly known. Although the Brazilian Amazon rainforest is an area of high biodiversity, very few gasteromycetes have been reported for the ecosystem. As a result of recent fieldwork in the state of Rondônia (Brazil's North Region) where gasteroid fungal specimens were collected, a new species was identified that is described here as *Cyathus amazonicus*. *Phallus indusiatus* and *Geastrum fimbriatum* are also newly recorded from the Brazilian Amazon rainforest.

Key words — gasteromycetes, bird's nest fungi, mycodiversity, Neotropics

Introduction

The Gasteromycetes represent a polyphyletic class, as confirmed by the recent molecular studies of Hibbett et al. (1997), Krüger et al. (2001), and Moncalvo et al. (2002). The term 'gasteromycete' is now generally applied informally to describe taxa having a gasteroid habit.

Lodge et al. (1995) consider the Amazon Basin an area of high fungal diversity (Lodge et al. 1995), yet studies on macrofungi of the Brazilian Amazon are few. Although gasteroid fungi often have conspicuous fruiting structures than occasionally are quite bizarre in form, only a handful of studies have focused on the gasteromycetes of Brazil (Baseia & Milanez 2001).

Two species of gasteroid fungi were recorded from the state of Amazonia by Berkeley & Cooke (1876): *Cyathus limbatus* Tul. & C. Tul., and *Scleroderma stellatum* Berk. Hennings (1904) later recorded eight species from the same state: *C. montagnei* Tul. & C. Tul., *Geastrum englerianum* Henn., *G. juruense* Henn., *G. saccatum* Fr., *G. scleroderma* Mont., *Lycoperdon epixylon* Berk. & M.A. Curtis, *L. juruense* Henn., and *Sclerangium brasiliense* Henn.

Capelari & Maziero (1988) reported four gasteroid species from the Amazon rainforest in the state of Rondônia, which they identified as: *Cyathus* sp., *Lycoperdon* sp., *Morganella* sp. and *Morganella fuliginea* (Berk. & M.A. Curtis) Kreisel & Dring.

The state of Rondônia, situated in northwestern Brazil, covers a 237,576 km^2 area, with nearly 20% of the area designated as conservation units (FIERO 2003). The capital city, Porto Velho (08º 45′ 48" S, 63º 54' 48" W), is located on the border between Rondônia and the state of Amazonas on the eastern shore of the Madeira River, a main tributary of the Amazon River. This city contains two important conservation units, the Municipal Natural Park of Porto Velho and the Cuniã Ecological Station. The Municipal Natural Park of Porto Velho, with a total area of 390.8 ha, was created in 1989 to preserve an open ombrophilous forest fragment, mostly in its native state with ~20% secondary or pioneer vegetation. The Cuniã Ecological Station, which covers a 53,221 ha area, was created in 2001. There the two main vegetation types are a open ombrophilous forest and a transition forest with savanna. The station boasts excellent forest conservation and protects the only natural lake and varzea (floodplain forest) complex on the Rio Madeira in Rondônia.

This paper adds to the general knowledge of gasteroid fungi from the Amazon rainforest in providing three new gasteromycete records from Rondônia, including a description of a new species, *Cyathus amazonicus*.

Materials and methods

All research collections were made during the rainy season in the Municipal Natural Park of Porto Velho and the Cuniã Ecological Station, in Porto Velho, Rondônia. Macroscopic examinations followed the usual techniques set forth for gastromycete taxonomic study; microscopical determinations follow Miller & Miller (1988). Specimens were identified using specialized literature (Brodie 1975, Sunhende 1989, Soto & Wright 2000, Calonge 2005, Baseia et al. 2006). Vouchers are deposited in URM (Holmgren & Holmgren 1998).

Taxonomy

Cyathus amazonicus Trierveiler-Pereira & Baseia, **sp. nov.** FIGURES 1–2

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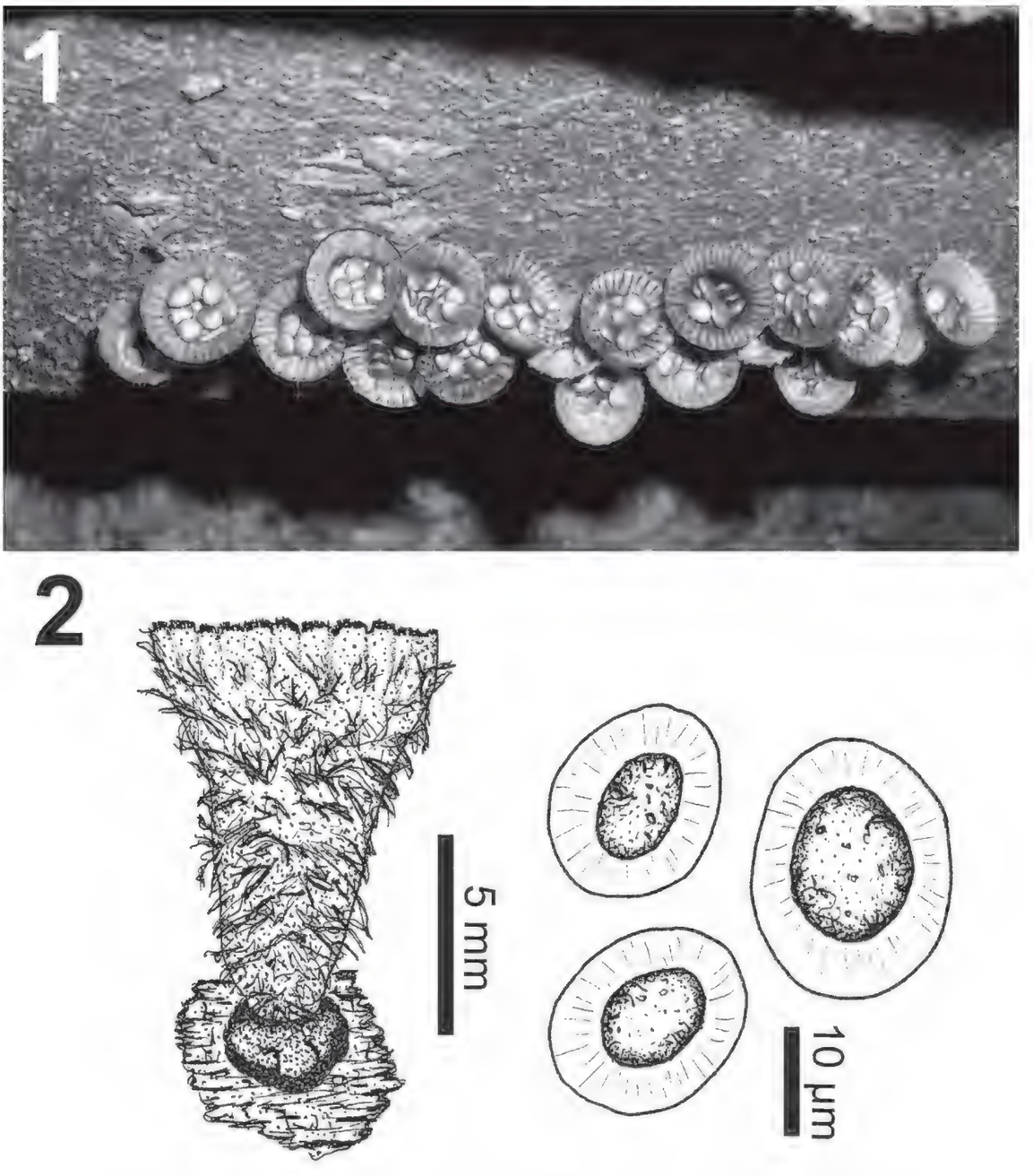
Peridium obconicum veil late obconicum, ad orem 9–11 mm altum, 5–7 mm latum; extus leviter plicatum, brunneum; intus plicatum, griseum veil brunneum; labium minute fimbriatum; peridiola 2–3 × 1.7–2 mm, lentiformia, cortex simplex, tunica subhyalina; sporae subglobosae vel late ellipsoideae, levibus, pariete crasso, 14–19 × 12–16 µm.

HOLOTYPUS — *Brasilia, Rondônia, Porto Velho, Estação Ecológica de Cuniã, ad lignum emortuum in silvis, leg. Gomes-Silva, 429. 15.II.2008* (*URM 80036*).



Figures 1-2. *Cyathus amazonicus*. 1. Basidiomata in situ (scale bar= 1 cm).
2. Basidiome in lateral view and basidiospores.

Peridium obconical to broad obconical, without stalk, 9–11 mm in height and 5–7 mm wide at the mouth, with a distinct reddish brown basal emplacement. Exoperidium finely plicate in the uppermost portions, very dark brown to grayish dark brown, hirsute; hairs yellowish brown, up to 1.5 mm long; mouth fimbriate. Endoperidium distinctly plicate, gray to brownish gray, smooth, shiny. Peridioles lentil-shaped, 2–3 × 1.7–2 mm, dark gray, shiny, 13–22 peridioles per basidiome; cortex composed of a single layer of hyphae, tunic thin, sub-colourless; funicular cord fibrous, yellowish white to bright yellow.

Basidiospores subglobose to broadly ellipsoid, thick-walled, hyaline, smooth, 14–19 × 12–16 µm.

Substrate — undetermined decaying hardwood species.

Taxonomic remarks — *Cyathus amazonicus* is diagnosed by the large, dark, finely plicate peridium, large (~3 mm diam) peridioles, and subglobose to broadly ellipsoid basidiospores. It resembles *C. helenae* H.J. Brodie and *C. lijiangensis* T.X. Zhou & R.L. Zhao in basidiospore size and shape. The peridium morphology and larger peridioles differentiate these two species from *C. amazonicus* (see Table 1).

Table 1. Comparison of *Cyathus amazonicus* to similar species.

Character/species	*C. amazonicus*	*C. helenae*	*C. lijiangensis*
Size of basidiomata (height × diam. mm)	9–11 × 5–7	7 × 5–6	6–9 × 3–6
Exoperidial colour	Very dark brown to grayish dark brown	Pale brown to gray	Gray to black
Exoperidial hairs	Long, conspicuous, sometimes aggregated into long tufts	Aggregated into nodules	Aggregated into narrow tufts
Peridioles (diam. mm)	2–3	2	1.5–2
Basidiospores (µm)	14–19 × 12–16	15–19 × 12–14	(14)15.5–18.5(–21) × 11–15(–16)
Distribution	Amazon rainforest	Canada, U.S.A., México	China
Reference	Present study	Brodie (1970, 1975)	Zhou et al. (2004)

Key to the described *Cyathus* species of Brazil

1a. Basidiospores ≤ 9 µm long 2
1b. Basidiospores > 9 µm long 3
2a. Endoperidium distinctly plicate; basidiospores 6–9 × 4–7 µm..... *C. berkeleyanus*
2b. Endoperidium not distinctly plicate; basidiospores 5–6 × 4 µm .... *C. microsporus*
3a. Exoperidia distinctly plicate 4
3b. Exoperidia not distinctly plicate 7
4a. Peridioles with single cortex 5
4b. Peridioles with double cortex 10
5a. Basidiospores subglobose to broadly ellipsoid ..... *C. amazonicus*
5b. Basidiospores ellipsoid..... 6
6a. Peridia externally brown to blackish, internally shining gray ..... *C. montagnei*
6b. Peridia externally chestnut brown, internally yellowish brown ..... *C. striatus*
7a. Peridial mouth abruptly flared outwards ..... *C. olla*
7b. Peridial mouth not flared outwards 8

8a. Peridioles shiny black and lacking tunica; exoperidia woolly to shaggy... *C. stercoreus*
8b. Peridioles shiny gray and with tunica present; exoperidia not woolly or shaggy... 9
9a. Exoperidia light coloured; peridioles with single cortex ..... *C. pallidus*
9b. Exoperidia dark coloured; peridioles with double cortex.....*C. triplex*
10a. Basidiospores very large, 30-40 µm long ..... *C. poeppigii*
10b. Basidiospores smaller, ≤ 19 µm long ..... *C. limbatus*

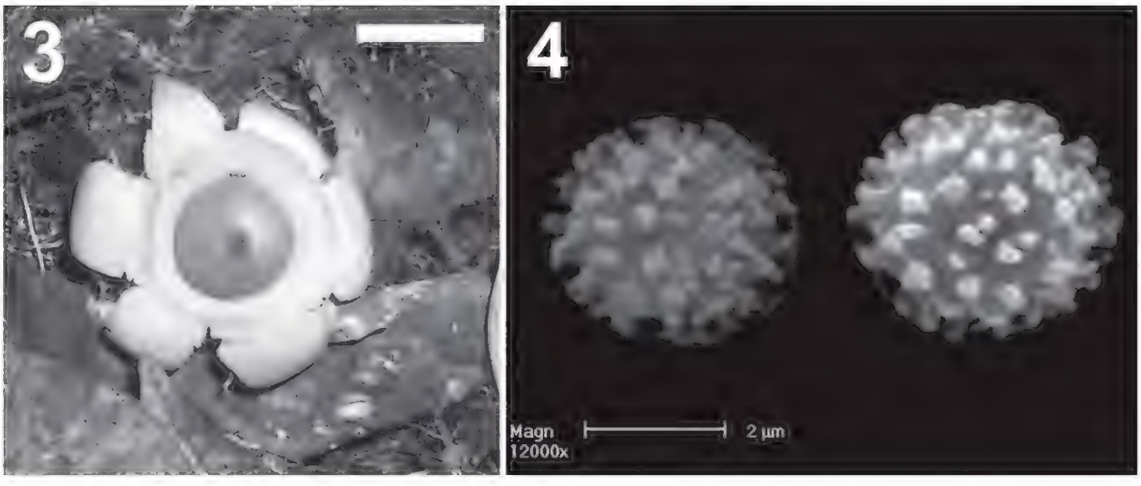
Geastrum fimbriatum Fr., Syst. Mycol. (Lundae) 3(1): 16 (1829). FIGURES 3–4

IMMATURE BASIDIOMATA not observed. EXPANDED BASIDIOME epigeous, 25 mm across and 23 mm high. EXOPERIDIUM non-hygroscopic, saccate, split into 6 rays with acute tips; mycelial layer dirty white, covered with adhering debris. Pseudoparenchymatous layer pinkish white when young, up to 3 mm thick. ENDOPERIDIUM sessile, globose, 13 mm wide and 9 mm high, without apophysis; surface of endoperidium grayish brown to dark brown; peristome fimbrillate, indistinctly delimited, darker than endoperidium; mature gleba very dark brown. BASIDIOSPORES spherical, reddish brown to brown in KOH 3%, 3.5–4.0 µm diam. including the ornamentation, SEM-pictures show ornamentation more or less columnar, rarely cofluent. CAPILLITIAL HYPHAE thick-walled, pale brown in KOH, solid or with narrow lumen, 3.5–6.0 µm diam., not branched.

SUBSTRATE — forest soil.

SPECIMEN EXAMINED — **BRAZIL. RONDÔNIA: Porto Velho**. Estação Ecológica de Cuniã. col. A. C. Gomes-Silva, 428. 15.II.2008 (*URM 80037*).

TAXONOMIC REMARKS — *G. fimbriatum* resembles *G. saccatum* in morphological characteristics; however, that species has larger basidiospores and the peristome is distinctly delimited by a groove (Baseia et al. 2004). *Geastrum fimbriatum*



FIGURES 3-4. *Geastrum fimbriatum*. 3. Basidiome in situ (scale bar = 2 cm). 4. Basidiospores.

may also be confused with *G. rufescens* Pers., which has smaller basidiospores that differ in ornamentation (Soto & Wright 2000). *Geastrum sessile* (Sowerby) Pouzar, *G. tunicatum* Vittad., and *G. argentinum* Speg. are now considered synonyms of *G. fimbriatum* (Sunhede 1989, Calonge 1998, Kreisel 2001, Soto & Wright 2000). This species has not previously been collected in the North Region of Brazil, having been recorded only in the states of Rio Grande do Sul (Rick 1961), Rio de Janeiro (Berkeley & Cooke 1876), and Pernambuco (Leite et al. 2007, Drechsler-Santos et al. 2008).

Phallus indusiatus Vent., Mém. Inst. Natl. Sci., Sci. Math. 1: 520 (1798).

Egg globose, subglobose to irregular shape, 2.1–3.9 cm in length × 2.8–4.2 cm in width, pinkish yellow to brownish yellow, rhizoids up to 7.3 cm in length. Pseudostipe cylindrical to subcylindrical, spongy, appearing white due to the absence of pigments, 4.4–7.3 cm high × 1.1–1.4 cm in width; indusium well developed, pendulous, yellowish white to dirty yellow, up to 5.0 cm long. Pileus campanulate, 1.9–3.9 cm high × 1.5–2.1 cm wide, with yellowish superficial folds that form a network, apex perforated; gleba black, shiny, viscous, foetid. Basidiospores ellipsoid, straight to slightly curved in side view, thin-walled, hyaline, smooth, 2.0–3.0 × 1.0–1.5 µm.

Substrate — forest soil.

Specimens examined — **BRAZIL. Rondônia: Porto Velho.** Parque Natural Municipal de Porto Velho. col. A. C. Gomes-Silva, 357. 21.I.2008 (*URM 78881*). Same locality. col. A. C. Gomes-Silva, 358. 21.I.2008 (*URM 78883*). Estação Ecológica de Cuniã. col. A. C. Gomes-Silva, 430. 15.II.2008 (*URM 78882*). Parque Natural Municipal de Porto Velho. col. A. C. Gomes-Silva, 643. I.2009 (*URM 80066*).

Taxonomic remarks — This species is easily recognized in the field owing to the presence of a well-developed veil and white pseudostipe (Baseia et al. 2006). *Phallus indusiatus* has been previously reported from the Brazilian states of Rio Grande do Sul (Rick 1961), Santa Catarina (Möller 1895), Paraná (de Meijer 2006), São Paulo (Viégas 1945, Bononi et al. 1981, Bononi 1984), and Rio Grande do Norte (Baseia et al. 2006). This is the first record from the Brazilian Amazon rainforest.

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Literature cited

Baseia IG, Maia LC, Calonge FD. 2006. Notes on *Phallales* in the Neotropics. Bol Soc Micol Madrid 30: 87–93.

Baseia IG, Cavalcanti MA, Milanez AI. 2004. Additions to our knowledge of the genus *Geastrum* (*Phallales: Geastraceae*) in Brazil. Mycotaxon 85: 409–416.

Baseia IG, Milanez AI. 2001. *Crucibulum laeve* (Huds.) Kambly in cerrado vegetation of São Paulo, Brazil. Acta Bot Bras 15(1): 13–16.

Berkeley MJ, Cooke MC. 1876. The fungi of Brazil, including those collected by J.W.H. Trail, Esq. M.A. in 1874. J Linn Soc, Bot 15: 363–398.

Bononi VLR. 1984. Basidiomicetos da Reserva Biológica de Mogi Guaçu. Rickia 11: 1–25.

Bononi VLR, Trufen SFB, Grandi RAP. 1981. Fungos macroscópicos do Parque Estadual das Fontes do Ipiranga depositados no Herbário do instituto de Botânica. Rickia 9: 37–53.

Brodie HJ. 1970. A previously unnamed species of *Cyathus* from the Cypress Hills, Alberta. Can J Bot 48: 749–750.

Brodie HJ. 1975. The Bird's Nest Fungi. University of Toronto Press, Toronto.

Calonge FD. 1998. *Gasteromycetes* I. *Lycoperdales*, *Nidulariales*, *Phallales*, *Sclerodermatales*, *Tulostomatales*. Fl Mycol Ibérica 3: 1–271.

Calonge FD. 2005. A tentative key to identify the species of *Phallus*. Bol Soc Micol Madrid. 29: 9–18.

Capelari M, Maziero R. 1988. Fungos macroscópicos do estado de Rondônia. Região dos Rios Jaru e Ji-Paraná. Hoehnea 15: 28–36.

de Meijer AAR. 2006. Preliminary list of the macromycetes from the Brazilian State of Paraná. Bol Mus Bot Munic 68: 1–55.

Drechsler-Santos ER, Wartchow F, Baseia IG, Gibertoni TB, Cavalcanti MAQ. 2008. Revision of the Herbarium URM I. *Agaricomycetes* from the semi-arid region of Brazil. Mycotaxon 104: 9–18.

FIERO; SEBRAE/RO. 2003. Rondônia: perfil socioeconômico industrial. Porto Velho.

Hennings P. 1904. Fungi amazonici a. cl. Ernesto Ule collecti: 1. Hedwigia 43: 154–186.

Hibbett DS, Pine EM, Langer G, Donoghue MG. 1997. Evolution of gilled mushrooms and puffballs inferred from ribosomal DNA sequences. Proc Natl Acad Sci, USA 94: 12002–12006.

Holmgren PK, Holmgren NH. 1998 [continuously updated]. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. <http://sweetgum.nybg.org/ih/>.

Kreisel H. 2001. Checklist of the gasteral secotioid *Basidiomycetes* of Europe, Africa and the Middle East. Österr Z Pilzk 10: 213–313.

Krüger D, Binder M, Fischer M, Reisel HK. 2001. The *Lycoperdales*. A molecular approach to the systematic of some gasteroid mushrooms. Mycologia 93(6): 947–957.

Leite AG, Calonge FD, Baseia IG. 2007. Additional studies on *Geastrum* from Northeastern Brazil. Mycotaxon 101: 103–111.

Lodge DJ, Chapela I, Samuels G, Uecker FA, Desjardin D, Horak E, Miller OK, Hennebert GL, Decock CA, Ammirati J, Burdsall HH, Kirk PM, Minter DW, Halling R, Læssøe T, Mueller G, Huhndorf S, Oberwinkler F, Pegler DN, Spooner B, Petersen RH, Rogers JD, Ryvarden L, Watling R, Turnbull E, Whalley AJS. 1995. A survey of patterns of diversity in non-lichenized fungi. Mitteilungen aus dem Eidgenössische Forschunganstalt für Wald-, Schee-, und Landwirtschaft 70: 157–173.

Miller Jr. OK, Miller HH. 1988. *Gasteromycetes*: morphology and developmental features. Mad River Press, Eureka.

Möller FAGJ. 1895. Protobasidiomyceten (Untersuchungen aus Brasilien). Bot Mitt Tropen 8: 1–179.

Moncalvo JM, Vilgalys R, Redhead SA, Johnson JE, James TY, Aime MC, Hofstetter V, Verduin JW, Larsson E, Baroni TJ, Thorn RG, Jacobsson S, Clémençon H, Miller Jr. OK. 2002. One hundred and seventeen clades of euagarics. Mol Phyl Evol 23: 357–400.

Rick J. 1961. *Basidiomycetes* Eubasidii no Rio Grande do Sul. Brasília. Iheringia 9: 451–480.

Soto MK, Wright JE. 2000. Taxonomia del gênero *Geastrum* (*Basidiomycetes, Lycoperdales*) en la provincia de Buenos Aires, Argentina. Bol Soc Argent Bot 34(3–4): 185–201.

Sunhede S. 1989. *Geastraceae* (*Basidiomycotina*). Morphology, ecology and systematics with special emphasis on the North European species. (Synopsis Fungorum 1). Fungiflora, Oslo.

Viégas AP. 1945. Alguns fungos do Brasil, 10: Gasteromicetos. Bragantia 5(9): 583–595.

Zhou TX, Zhao LZ, Zhao RL, Chen YI. 2004. Bird's nest fungi from China. Fungal Diversity 17: 243–251.